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Robot kit with LEGO system sensors

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Abstract — the aim of this paper is to design and program a model of intelligent robotic sensory system based on the LEGO kit. The design is a useful laboratory model, whether industrial or logistic, to handle unattended objects and to further shift them into a production or transport process. Robot built with LEGO Mindstorms, designed to build automated robotic models. Management is provided by the NTX control unit, which can, if necessary, upload any proposed program. The robot is powered by three servomotors and monitors its surroundings through three types of sensors, such as color sensor, ultrasonic sensor, and pressure transducer.

***Keywords* — sensors, robot control unit, actuators, software**

I. INTRODUCTION

Factory robots and robots with sensory systems are used around two decades. Their use is largely represented mainly in the automotive industry, but over time they started to get into other spheres such as production, working materials but also manipulation of objects without operator assistance, and not least the sensory robots have become increasingly even household.

II. BACKGROUND

When drawing up the sensory robot is needed to solve many problems. Mechanical parts, which are robots made of different shapes and not all are compatible. Since the mass-produced, can be expensive or unavailable. Solve this problem LEGO Company, which in 1995 commissioned and launched LEGO technic. This step is gradually supplementing and modernizing parts of the market received a large number of compatible and affordable components. Further modernization and the need to control a robot designed by the company came with the new LEGO Mindstroms, which allows almost any model to build a robot to demonstrate under laboratory conditions. The primary part of the kit is a so-called smart cube NTX, which is within us includes a control unit with memory, allowing it to upload to a program created in a graphics program, LEGO Company which comes with a control unit via USB or Bluetooth connection to computer. Other components are modular systems such as touch sensors, light, ultrasonic. Using sensors, the robot is able to perceive their environment and obtain information about it. For the robot are designed interactive servo motors which are controllable number of turns or angles from 1 to 360 degrees. Interactive servo motors and sensors are attached to the control unit with six venous cables.

III. TECHNICAL SPECIFICATIONS

Intelligent Cube NTX, Fig.1, is operated with 32-bit AMR7 micro control unit, 256 Kbyte Flash, 64 Kbyte RAM. Communication with PC is provided with Bluetooth Class II. through which it is possible not only to communicate with PC but also to remotely control the robot to 10 meters or USB port, 12 Mbit / s. The control unit has 4 input ports for sensors that are connected to a control unit using a 6 wire cable digital platform (One port includes IEC 61158 type 4/EN 50 170 compatible port for future use). Servomotors are used to control three output ports, 6-wire cable digital platform. The

Fig. 1. Intelligent Cube NTX

control unit has an LCD graphic display 100 x 64 pixels. Sounds used for speaker with sound quality 8 kHz. Audio channel has an 8-bit resolution and 2 to 16 kHz sample frequency. NTX cube is in itself basic software to control various sub-programs, testing and calibration programs. NTX cube can also be controlled using the buttons and navigating the menu. Power is supplied from the adapter or AA batteries or special LEGO battery.

IV. DISTRIBUTION OF SENSORS AND MOTORS

A. Sensor colour

Fig.2 Sensor of colour

Thanks to its construction, the sensor can be used for the recognition of six colours, detects the intensity of light or to measure the intensity of light coloured surfaces. The sensor may serve largely in deciding a robot. Program is possible for the robot to enter a variety of outputs, which carried by a selected colour. The sensor can also shine in four colours red blue green and white. This feature can be used to function as a robot, each colour can be programmed a certain property. For example such sensor can be used for mobile robots to determine the sensor path after which the robot to go.

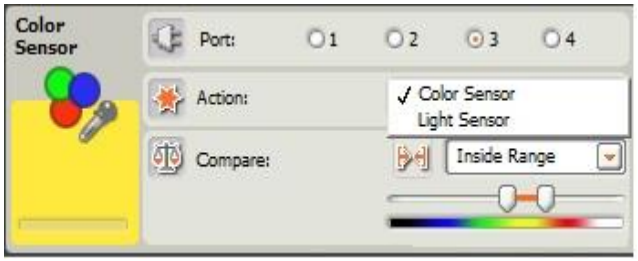

Fig. 3. Palette colour setting properties of the sensor

B. Touch Sensor

Fig.4 Touch Sensor

Touch sensor provides the robot ability to touch. The sensor operates in three positions as press, release, or at once. For each property that can be programmed a certain input.

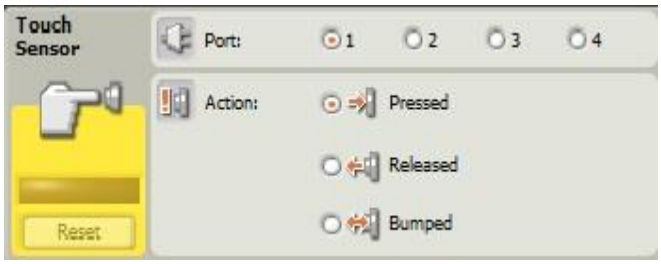

Fig.5 A variety of setting properties of the pressure sensor

C. Ultrasonic sensor

Fig.6 Ultrasonic sensor

The ultrasonic sensor is used to detect the distance of objects to avoid obstacles, tracing objects. Sensor measures distance in centimetres or inches, which may NTX controller display to display. It can measure the distance from 0 to 255 cm with an accuracy of + / - 3 cm. The sensor uses the scientific principles of sound transmission and reflection from obstacles. Followed by calculating the period during which the reflected sound will come back to the sensor the distance is determined.

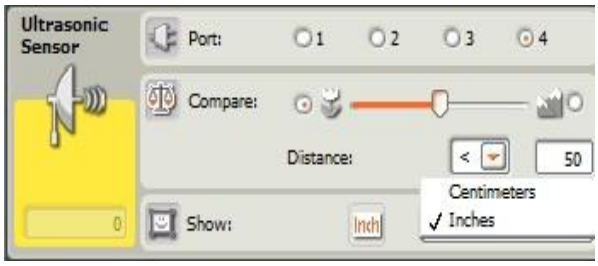

Fig.7 A variety of adjustment features an ultrasonic sensor

D. Interactive Servo Motor

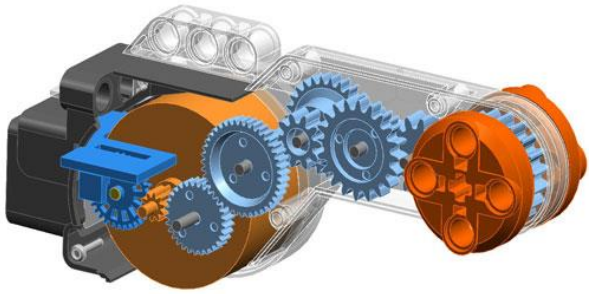

Fig.8 Interactive Servo Motor

The robot provides three interactive servo motors. They are already constructed for the transfer of sufficient strength. Servo properties are set different performance aspects of the program on your PC.

Each engine has a built-in rotation sensor that provides precise robot motions on both sides. The rotation sensor measures the rotation in degrees of engine rotation or independent on the basis of complete revolutions. One revolution of the engine corresponds to 360 degrees with an accuracy of + / - 1 degree. Actuator can be set to infinite rotation, which ends with one of the sensors or rotation time in seconds and turning in grades. The PC software is set rotational speed of servo motor and also the strength with which it works. Motors are connected to an intelligent glance at ports NTX ABC.

Fig.9 The range setting of Servo Motor properties

V. How Designed Robot Operates

Sensory robot model is designed to manipulate objects in the automotive industry. Already mentioned the robot by three motors. The first actuator is connected to the control unit NTX on A output port and it controls the rotating robotic arm in the direction of right and left at an angle of 360 degrees through transfer to streamline its strength. Vertical bearing arm is attached to the bottom of the robot to transfer actuator A. The vertical arm can move the horizontal arm in the direction up and down at an angle of 150 degrees. It is operated actuator, which is connected to output port B to control unit NTX. Mass shoulders require gearing and this part. The upper horizontal arm incorporates a servo motor to open and close a robotic hand, whereby the robot can grasp objects. The servomotor is connected to the output port C in the control unit NTX. Robotic arm can be changed as appropriate depending on what object should be transferred. The robotic arm for carrying objects in special containers uses this case. Sensors are used for robot perception. As the first, which triggers the whole process is an ultrasonic sensor. The program enables the robot when the robot approaches an object over a distance of 3 cm and ceases to move. The sensor is placed in front of the bottom of the robot. The sensor is connected to the input port 1 controller NTX. If not close to any object or robot vehicle, the robot is in stand-by mode. If the robot is close to a container, the robot program is run, causing the robot tipped over the container to fetch the container, which is. Transported containers are marked in colour. The robot is set to distinguish three types of colour and the red, green and blue. This feature ensures colour sensor that recognizes six kinds of colours and is connected to the input port 2 controllers NTX. If the container is red, the robot picks up the container and moved it to his right side and deposited him there. If the vehicle is a container with green, the robot picks up the container again and put it on the left side. Repository is used for the last type of sensors and pressure. Sensors are in the starting position extended. If the robot is positioned on the sensor storage container is inserted. This robot acquires information that the repository is busy. If container transports the vehicle, the vehicle is marked in blue and the robot receives information that the container is loaded. Loading the container is again ejected pressure sensor for robot repository and gathers information that does not contain any cost, and thus returns to the starting position.

Fig.10 Example of program LEGO Mindstorms

VI. PROGRAMMING

Creating programs for smart cube NTX is secured using LEGO Mindstorms NTX 2.0 software. The software is designed for easy connection to PC via Bluetooth or USB. Use the icons with the logic operation is ensured decision robot. Basic icons are icons for the movement of engines, adjusting their properties, recording sound effects, making loops and switches. Each actuator can set different properties than the length of motion, strength, speed, and port connectivity. For interactive servo motors feature is implanted base, that in case of blocking actuator program immediately assess the situation and on that basis is able to prematurely terminate the program, to avoid damaging the hardware. It is also possible to set the rotation of actuator properties. Sensors also have their icons, which are set in their properties. For the ultrasonic sensor can be set up motion detection or measuring distance. Colour sensor can be set using software as a coloured lamp that can illuminate four colours, or as light intensity sensor recognition and six colours. For the pressure sensor can be adjusted his position, compression, impact and eject. To decide the robot and the processing of input information used e-switch or loop. If you have a robot perform a task, it is necessary to enter basic information requirements and using that to compare them with the information input. Loop is used to re-perform a specific task, until there is a change of input. The program can still use the pause, which can be adjusted by the length of time required for stopping the process or a variation of the input. The software also contains logical and mathematical comparison, randomly generated functions. The last part is the servo calibration and reset to its starting position. In compiling the program to deploy icons on the desktop and, where appropriate, shall be connected to each other or to create e-switch or for more sub-loops. Programming is based on the base of tree diagrams.

VII. CONCLUSION

The main task of my work was to construct a model of sensory recovery robot technology production line for production of automobile components, using the LEGO Mindstorms.

Robot could be used in practice in logistics processes objects transported in an automated process using the minimum operator. Adding more moving parts other sensors can expand properties of the robot. Created by the requirement to use the next time you synchronize the control unit and programs running on them at the same time. This task is beyond the described problems.

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